A Comprehensive Parameterization of Heterogeneous Ice Nucleation of Dust Surrogate

Research Highlight

Reducing uncertainty in predicting climate change requires understanding ice clouds. At supercooled temperatures, many kinds of airborne aerosol particles can promote ice nucleation. In this paper, researchers, including scientists at DOE's Pacific Northwest National Laboratory, developed and tested a new heterogeneous ice nucleation parameterization that covers a wide temperature range.

Hematite particles were used as a proxy for atmospheric dust particles. The ice nucleation active surface-site density (INAS) was obtained from Aerosol Interaction and Dynamics in the Atmosphere (AIDA) cloud chamber experiments. Measurements showed several pathways to nucleate ice, depending on temperature and relative humidity. Observations at temperatures lower than #60 °C revealed higher relative humidity was necessary to maintain a constant active surface site density. The new parameterization was implemented into two numerical models with different complexity to investigate the sensitivity of the simulated cirrus cloud properties to the new parameterization in comparison to existing ice nucleation schemes.

The results showed that the new AIDA-based parameterization leads to order of-magnitude-higher ice crystal concentrations compared to an empirical parameterization, further inhibiting the homogeneous nucleation in lower-temperature regions. The cloud simulation results suggest atmospheric dust particles that form ice nuclei at temperatures below #36 °C can potentially have a stronger influence on cloud properties, such as cloud longevity and initiation, compared to previous parameterizations. The new parameterization, which is based on the INAS approach, supports examination of ice nucleation in a simple framework for modeling applications.

Reference(s)

Hiranuma N, M Paukert, I Steinke, K Zhang, G Kulkarni, C Hoose, M Schnaiter, H Saathoff, and O Möhler. 2014. "A comprehensive parameterization of heterogeneous ice nucleation of dust surrogate: laboratory study with hematite particles and its application to atmospheric models." Atmospheric Chemistry and Physics, 14, 13145-13158.

Contributors

Kai Zhang, *Pacific Northwest National Laboratory*

Working Group(s)

Cloud-Aerosol-Precipitation Interactions